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Technology Center Chicago, Illinois 60616

(NASA CR-...) Report No. IITRI-C6018-5
(Monthly Progress Report)

INVESTIGATION OF LIGHT SCATTERING IN HIGHLY REFLECTING PIGMENTED COATINGS

National Aeronautics
and Space Administration

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Report No. IITRI-C6018-5
(Monthly Progress Report)

INVESTIGATION OF LIGHT SCATTERING IN HIGHLY REFLECTING PIGMENTED COATINGS

November 1 ~~through~~ December 1, 1963

National Aeronautics and Space Administration

(Contract NASr-65(07))
IITRI Project C6013

I. INTRODUCTION

This is the fifth monthly progress report on IITRI Project C6018, Contract NAS-~~1~~R65(07). The period covered is November 1 ~~to~~ December 1, 1963.

II. CRYSTAL GROWTH

Size control over the AgCl crystals grown by the simultaneous additions of stoichiometric quantities of $AgNO_3$ and KCl has been the object of research during the past period. We have attempted to control the crystal size by varying the degree of supersaturation and the length of aging. Silver halides have low solubilities, and the rapid addition of reagent allows crystallization to proceed from a large number of centers or nuclei. When these primary particles are about the same sizes and have the same solubilities, there is little tendency for the larger particles to grow at the expense of the smaller ones. If the precipitate is formed under conditions in which it is somewhat soluble, or if the primary crystals have a solubility that is much greater than larger crystals,

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then crystallization tends to start from fewer nuclei and larger crystals tend to grow. This is the effect, noted by Berry, from the addition of ammonia and other similar growth modifiers. In this regard, the solubility product of AgBr at 25°C is 7.7×10^{-13} gmoles/liter and for AgCl, 1.6×10^{-10} gmoles/liter, and the use of ammonia with AgCl might not have the same effect on crystal size as it does with AgBr. With some crystalline substances, aging at elevated temperatures causes the smaller particles to dissolve slowly and recrystallize on the larger ones. The greater solubility of the smaller crystals is attributed to the existence of more isolated atoms or groups of molecules which can more readily break away from the crystal.

The production of small crystals can be maximized by decreasing the solubility of the crystals by the common ion effect, removing all complexing agents, producing the crystals at a lower temperature, adding the reagents rapidly to quickly attain and maintain a high degree of supersaturation, and not aging the crystals. The production of large crystals can be maximized by increasing the solubility of the crystals through the addition of complexing agents, producing the crystals at elevated temperatures, adding the reagents slowly, and aging the crystals.

Several batches of AgCl crystals have been prepared by the methods outlined above; the most significant factors appear to be the aging and the concentration of crystals. The AgCl particles (batch 12) shown in Figure 1 were prepared by using

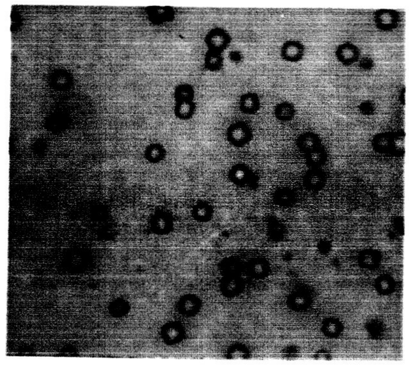
3.0 N solutions of KCl and $AgNO_3$ and 100 ml of a 30 g/liter gelatin suspension. Figure 2 shows the same batch one week later; it was stored in a refrigerator during the week. Figures 3 and 4 show AgCl particles (batch 14) prepared from 0.2 N solutions of KCl and $AgNO_3$ and 100 ml of a 5 g/liter gelatin suspension. These electron photomicrographs were taken five and ten days after preparation. Although no observations were made on batch 14 directly after preparation, it appears to be well stabilized; Figure 2 shows many small crystals welded to the larger crystals. It is postulated that the greater distance between crystals in the weaker suspensions helped stabilize the suspension.

III. ANGULAR SCATTERING OF LIGHT BY SILVER CHLORIDE FILMS

Attempts were made to determine the angular distribution of scattered light by the monodispersed AgCl films described in our last quarterly report. The relative concentrations of AgCl in gelatin were 0.06, 0.123, 0.185, and 0.246 M, and the films were spread on a quartz substrate (IITRI Report C6018-4). The Brice-Phoenix light-scattering photometer with the schematic film orientation shown in Figure 5 was used for this study.

For the particular experimental arrangement employed, the intensity of scattered light per unit area of film, $I(\theta)$, at an angle, θ, is given by

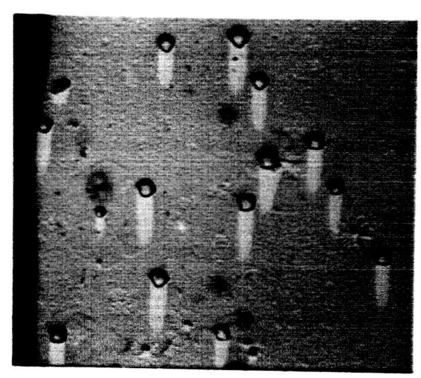
$$I(\theta) = \frac{F(\theta)}{A \sin \theta}$$



Batch 1
(10,500x)

Batch 2
(10,000x)

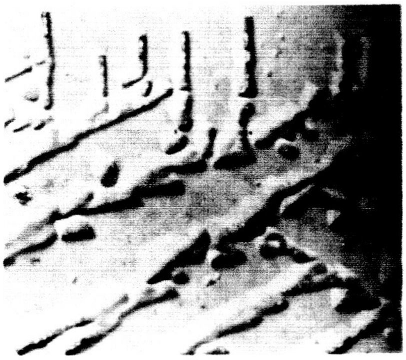
Batch 3
(10,500x)



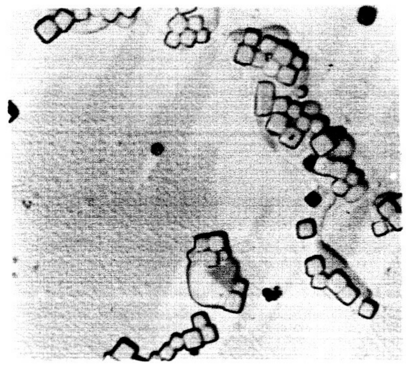
Batch 4
(10,000x)

FIGURE 1

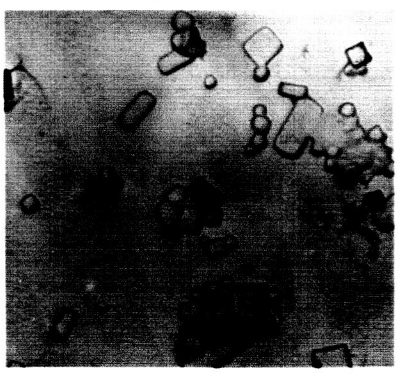
ELECTRON PHOTOMICROGRAPHS OF SILVER SHLORIDE CRYSTALS



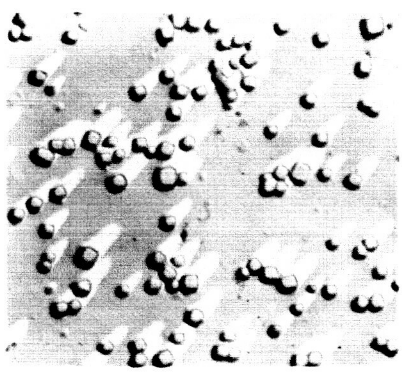
Batch 5
(5000x)



Batch 6
(10,000x)



Batch 7
(10,000x)



Batch 8
(10,000x)

FIGURE 2

ELECTRON PHOTOMICROGRAPHS OF SILVER CHLORIDE CRYSTALS

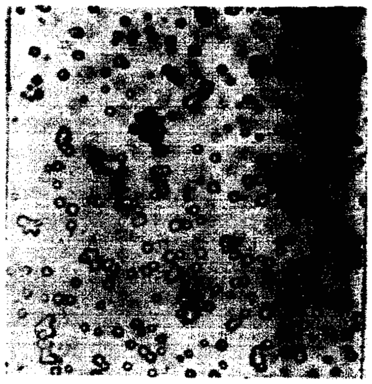


Figure 1

Batch 12
Immediately after
Preparation
(10,000x)

Figure 2

Batch 12
One Week
after Preparation
(5,000x)

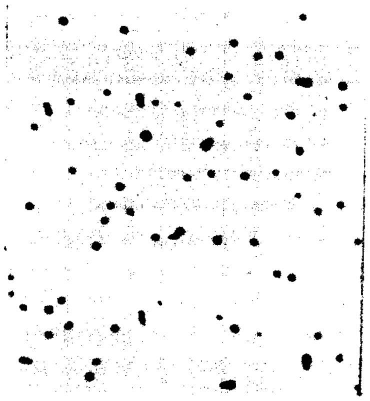


Figure 3

Batch 14
Five days
after Preparation
(5,000x)

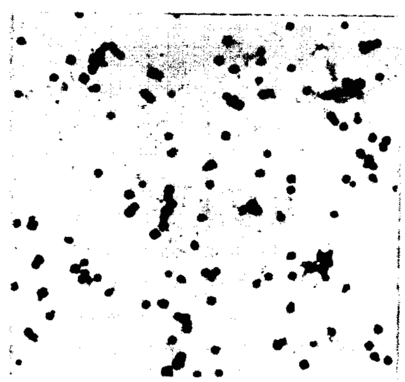


Figure 4

Batch 14
Ten Days
after Preparation
(5,000x)

ELECTRON PHOTOMICROGRAPHS OF SILVER CHLORIDE CRYSTALS

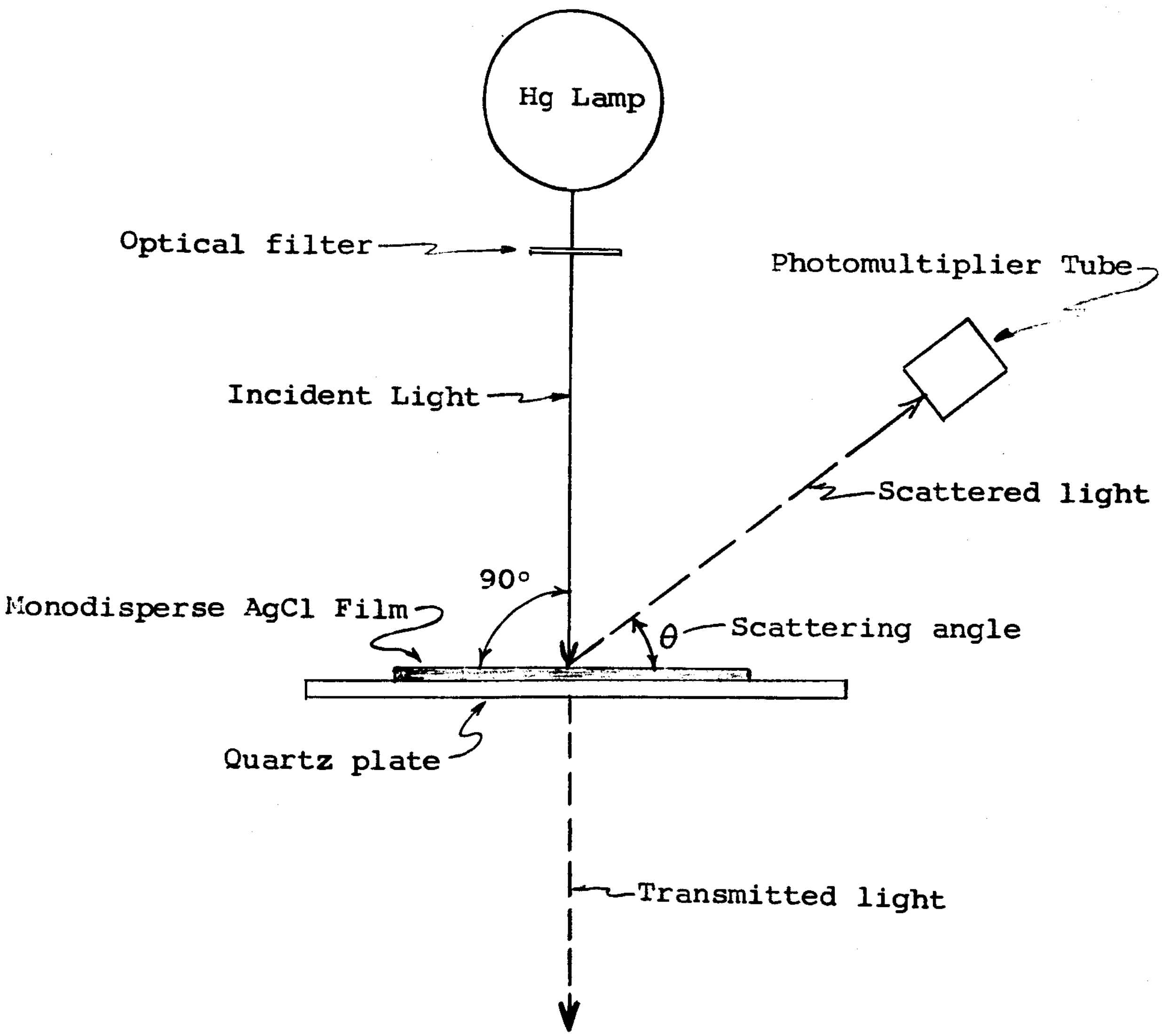


Figure 5

BRICE-PHOENIX LIGHT-SCATTERING PHOTOMETER where $I(\theta)$ = intensity/unit area

(θ) = the angle of observation measured from the plane of the film

A = the area covered the illuminating beam

$F(\theta)$ = total light flux at angle θ.

The measurements were obtained by using green (0.546 μ) and blue (0.436 μ) mercury lines as sources of monochromatic light. One measurement was also obtained with total mercury radiation, and without filters; in this case approximately 90% of the energy was the ultraviolet mercury line (0.254 μ).

The results are summarized in Figures 6, 7, and 8 and show the intensity/area (arbitrary relative intensity units) as a function of the angle of observation. The notation of angles corresponds to the one used with the Brice-Phoenix light-scattering photometer. An interpertation of these results has not been made and possibly should wait until supporting data are obtained.

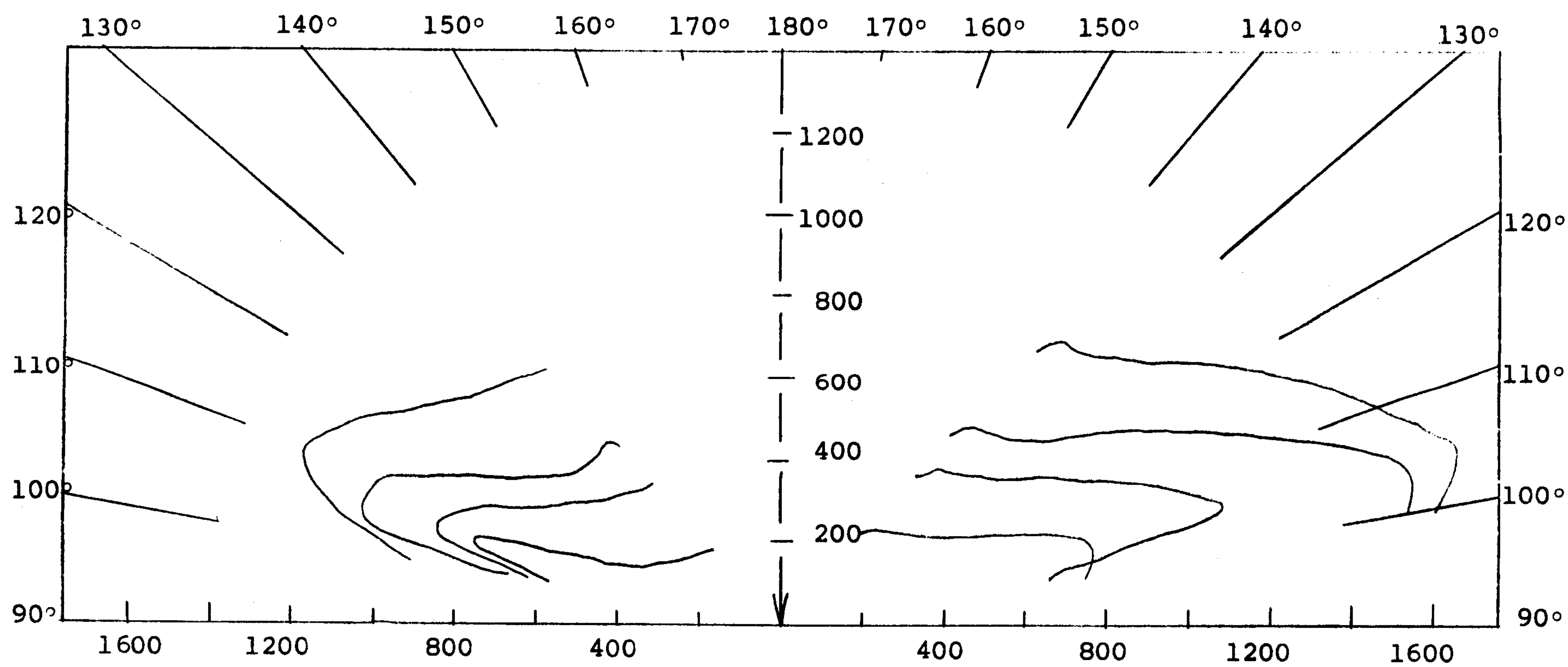


Figure 6

INTENSITY/UNIT AREA OF BLUE MERCURY LINE
VERSUS ANGLE OF OBSERVATION

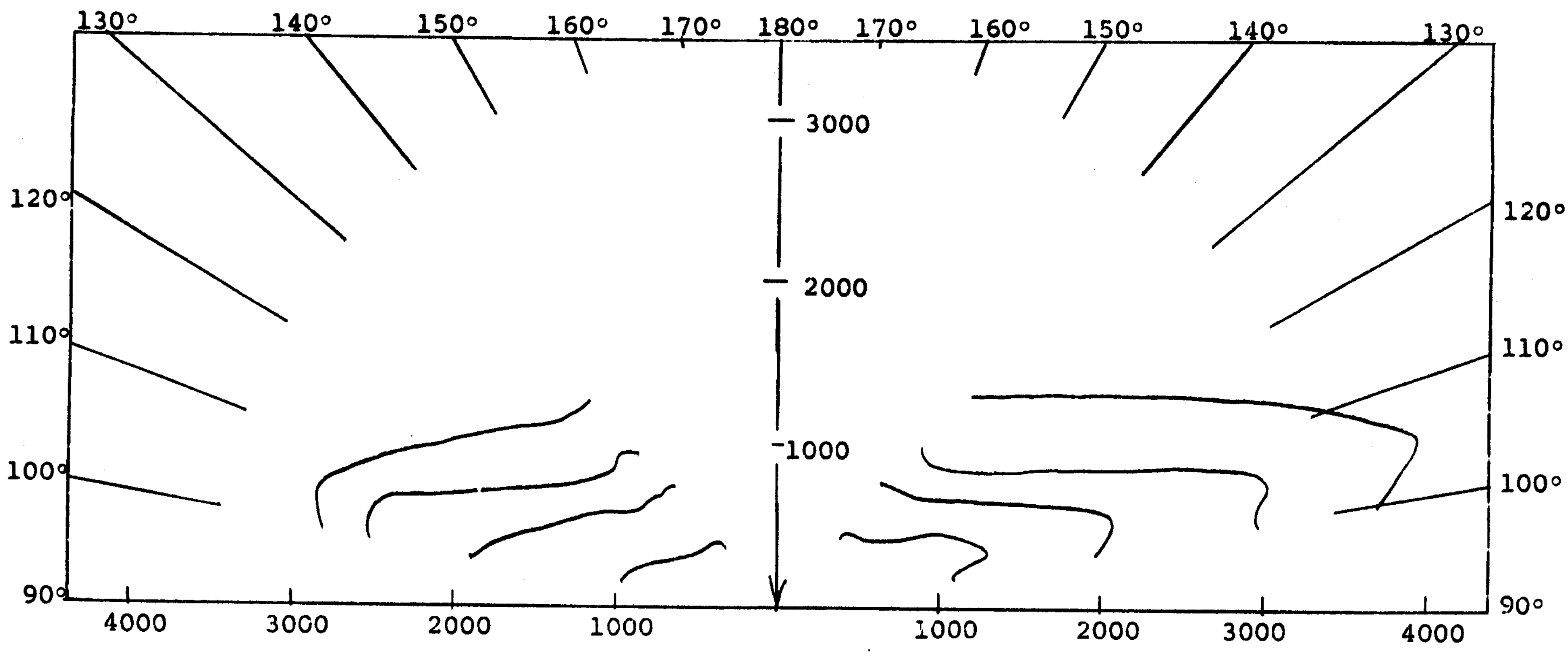


Figure 7

INTENSITY/UNIT AREA OF GREEN MERCURY LINE
VERSUS ANGLE OF OBSERVATION

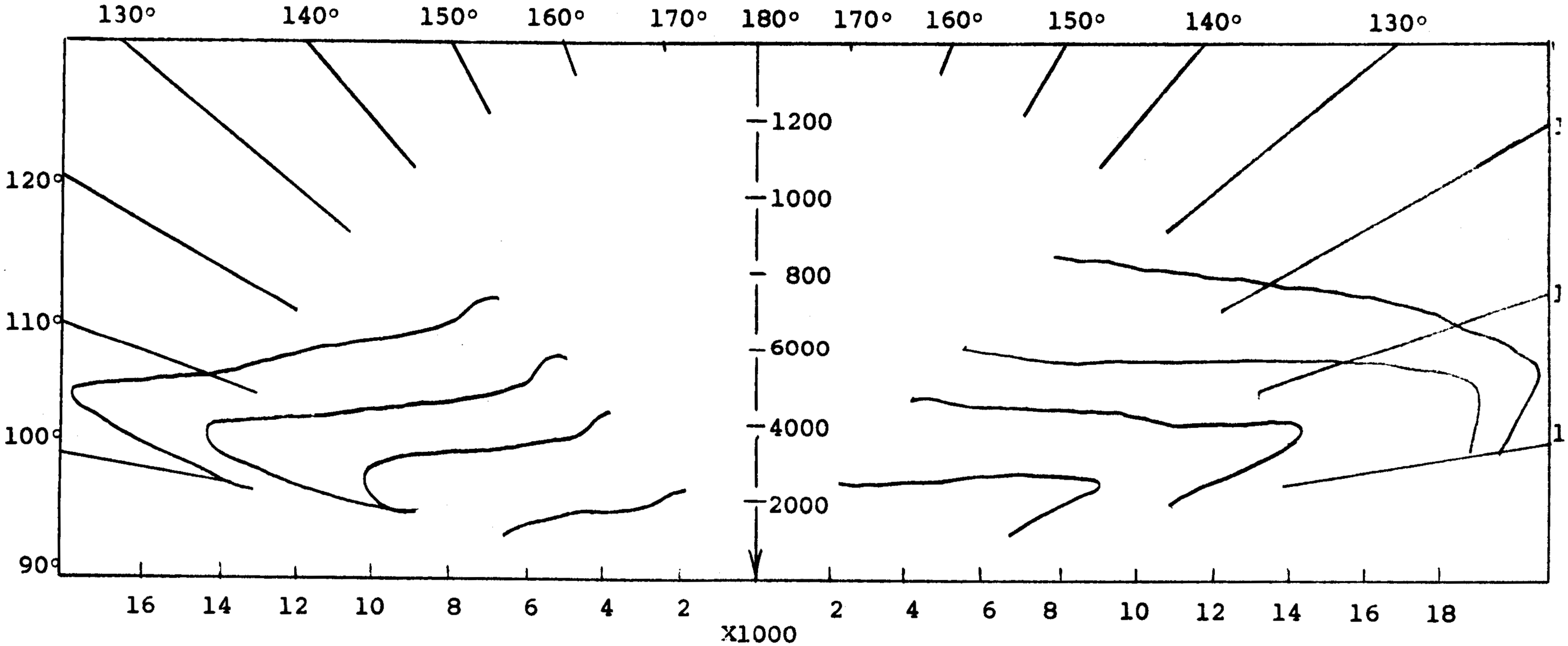


Figure 8

INTENSITY/UNIT AREA OF TOTAL MERCURY RADIATION
VERSUS ANGLE OF OBSERVATION

IV. PERSONNEL AND RECORDS

Personnel who contributed to this report are Mrs. J. Allen, Messrs. Victor Razinunas, John Stockham, and Dr. Sidney Katz. Results are recorded in Logbooks C13738, C13906, and C14085.

Respectfully submitted,

IIT RESEARCH INSTITUTE

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